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## THE REFRACTIVE INDEX OF BEESWAX.

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Lewkowitsch, in Chemical Technology and Analysis of Oils, Fats, and Waxes, recommends refractometric examination as a preliminary test in the examination of beeswax, giving as the limits between which pure beeswax should fall,  $42.9^{\circ}$ – $45.6^{\circ}$ , butyro-refractometer scale, calculated to  $40^{\circ}$  C. These figures were obtained from the work of Werder<sup>1</sup> and Berg,<sup>2</sup> who made the determinations at temperatures ranging between  $70^{\circ}$  and  $84^{\circ}$  C. and then calculated them to  $40^{\circ}$  C. Neither Werder nor Berg in their original articles give the figures actually observed nor explain how their calculations were made, but it is assumed that they added to the observed figures the correction  $0.55^{\circ}$  butyro for each degree centigrade between the observed figures and  $40^{\circ}$  C.; the correction value  $0.55^{\circ}$  being generally used for all fats and oils when calculated to  $40^{\circ}$  C. In this laboratory an Abbe-Zeiss direct-reading refractometer is used, and for beeswax a correction of 0.00037 per degree centigrade was found necessary. This figure was obtained by taking the refractive index at  $65^{\circ}$ ,  $75^{\circ}$ , and  $85^{\circ}$  C. and dividing the difference in the reading by the difference in degrees centigrade. This correction of 0.00037 per degree centigrade was found to be practically constant between these temperature limits not only for all pure beeswax examined, but also for those which, upon further examination, showed adulteration.

As beeswax is a solid at  $40^{\circ}$  C. and the refractive index is always read on the melted wax at some temperature above  $63^{\circ}$  C., it seems desirable to eliminate the use of the calculation to  $40^{\circ}$  C. and to set limits for the refractive index of pure beeswax at some temperature above the melting point. For this purpose a number of samples of known purity and origin, obtained from the Bureau of Entomology, United States Department of Agriculture, and some others purchased on the open market were examined. All of these had been analyzed by the drug laboratory of the Bureau of Chemistry. The readings were made at  $65^{\circ}$ ,  $75^{\circ}$ , and  $85^{\circ}$  C., and the results are given in the following tables. Table I consists of the figures obtained on the

samples of pure beeswax secured from the Bureau of Entomology. Table II shows the results on those samples obtained in the open market, many of them adulterated samples. In the column headed "Remarks" are placed conclusions as to the nature of the sample based on the chemical analysis.

TABLE I.—*Refractive index readings at different temperatures on beeswax samples of known purity.*

Contract laboratory No.	Refractive index.			Locality.
	At 65° C.	At 75° C.	At 85° C.	
12616.....	1.4458	1.4424	1.4390	Not given.
12617.....	1.4458	1.4425	1.4391	Do.
12618.....	1.4456	1.4420	1.4380	Do.
12619.....	1.4454	1.4418	1.4378	Do.
12620.....	1.4449	1.4414	1.4380	Mexico.
12621.....	1.4453	1.4416	1.4377	North Carolina.
12622.....	1.4460	1.4426	1.4388	Wisconsin.
12623.....	1.4441	1.4403	1.4365	Cuba.
12624.....	1.4449	1.4412	1.4375	Habana.
12625.....	1.4448	1.4410	1.4374	Haiti.
12626.....	1.4448	1.4414	1.4374	Southern States.
12627.....	1.4458	1.4424	1.4387	Africa.
12628.....	1.4456	1.4420	1.4384	New York.
12629.....	1.4488	1.4451	1.4415	San Domingo.
12656.....	1.4440	1.4402	1.4363	Not Given.
12657.....	1.4443	1.4406	1.4367	Wisconsin.
12658.....	1.4460	1.4424	1.4388	Illinois.
12659.....	1.4449	1.4413	1.4377	Texas.
12660.....	1.4444	1.4405	1.4368	Iowa.
12661.....	1.4450	1.4413	1.4378	Utah.
12662.....	1.4458	1.4422	1.4384	Iowa.
12663.....	1.4444	1.4405	1.4368	California.
12664.....	1.4436	1.4398	1.4361	Hilo.
12665.....	1.4434	1.4398	1.4361	Do.
12666.....	1.4435	1.4400	1.4362	Do.
12667.....	1.4447	1.4410	1.4375	Not given.
12801.....	1.4470	1.4433	1.4395	Minnesota.

TABLE II.—*Refractive index readings at different temperatures on commercial samples.*

Contract laboratory No.	Refractive index.			Remarks.
	At 65° C.	At 75° C.	At 85° C.	
12630.....	1.4463	1.4425	1.4389	Pure wax.
12631.....	1.4159	1.4425	1.4387	Do.
12632 <sup>1</sup> .....	1.4379	1.4340	1.4302	Paraffin present.
12633.....	1.4456	1.4421	1.4387	Pure wax.
12634 <sup>1</sup> .....	1.4380	1.4344	1.4307	Paraffin present.
12635 <sup>1</sup> .....	1.4379	1.4342	1.4302	Stearic acid and paraffin present.
12636.....	1.4540	1.4505	1.4505	Resin present.
12637 <sup>1</sup> .....	1.4375	1.4238	1.4301	Paraffin present.
12638 <sup>1</sup> .....	1.4350	1.4313	1.4275	Do.
12639.....	1.4448	1.4410	1.4372	Pure wax.
12640.....	1.4454	1.4416	1.4380	Do.
12641 <sup>1</sup> .....	1.4421	1.4384	1.4346	Paraffin present.
12642 <sup>1</sup> .....	1.4363	1.4323	1.4284	Do.
12643.....	1.4447	1.4410	1.4372	Pure wax.
12644.....	1.4437	1.4400	1.4364	Do.
12645.....	1.4440	1.4402	1.4368	Do.
12646.....	1.4445	1.4410	1.4372	Do.
12647.....	1.4438	1.4401	1.4362	Do.
12648 <sup>1</sup> .....	1.4421	1.4384	1.4348	Paraffin present.
12649 <sup>1</sup> .....	1.4335	1.4300	1.4290	Stearic acid and paraffin present.
12650 <sup>1</sup> .....	1.4342	1.4304	1.4268	Paraffin present.
12651.....	1.4439	1.4402	1.4365	Do.
12652 <sup>1</sup> .....	1.4345	1.4307	1.4269	Do.
12653.....	1.4445	1.4408	1.4372	Pure wax.
12654 <sup>1</sup> .....	1.4355	1.4318	1.4280	Paraffin present.
12655.....	1.4441	1.4406	1.4369	Pure wax.

<sup>1</sup> Grossly adulterated samples.

Upon examining the tables it will be found that the refractive index at 75° C. for pure beeswax falls between 1.4398–1.4451. Table II shows that the refractive indices of all those samples bought in the open market, which on chemical analysis appeared to be pure, fell within the limits for pure beeswax (1.4398–1.4451); while of the adulterated samples only one fell within these limits. This sample was No. 12651, which has a refractive index of 1.4402, a figure very close to the lowest value obtained for pure beeswax. In this instance it is quite possible that the beeswax had a high refractive index and was adulterated with a small amount of paraffin. One sample (No. 12636), showing a high refractive index of 1.4540, proved on chemical examination to have resin in it. It was not possible to obtain a clear reading of this wax at 65° C. Those samples which have a very low refractive index proved to be grossly adulterated with either paraffin or stearic acid, or both. A temperature of 75° C. was selected because at this point all beeswaxes are liquid, a clear sharp line can be obtained in the refractometer, and it is comparatively easy to make the reading.

It is seen that the determination of the refractive index of beeswaxes is of great help in detecting gross adulteration and will generally reveal small adulterations, samples containing only a small amount of foreign material generally giving figures outside the limits mentioned, namely, 1.4398–1.4451 at 75° C. The results obtained show also that it is both unnecessary and unwise to calculate the refractive index to the butyro scale at 40° C., for the following reasons: (1) It is unreasonable to report the refractive index of a wax at a temperature at which it is an opaque solid, when the actual reading is made on the melted wax. (2) The calculation consumes time. (3) A clear reading can be obtained at 75° C. and the figures obtained can be reported unchanged.

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